PREFERENCES OF ADRENALECTOMIZED RATS FOR SALT SOLUTIONS OF DIFFERENT CONCENTRATIONS

BY

JAMES PATRICK CHAPLIN

A. B., University of New Mexico, 1940

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AN ABSTRACT OF A THESIS

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Introduction

From studies of changes in salt intake and salt taste thresholds following adrenalectomy, Richter **(1, 2)** has demonstrated that animals take greatly increased amounts of salt when allowed a free selection and further show an ability to discriminate between distilled water and salt solutions of much weaker concentrations than do normal rats. The purpose of this research has been to investigate how such physiological and behavioral changes brought about by adrenalectomy affect preferences for different concentrations of salt solution when a series of such solutions is presented simultaneously. A secondary purpose was to study the effect of adrenalectomy on the selection of other foods commonly used in synthetic self-selection diets.

Procedure

Three groups of albino rats were used in the experiment. Group I consisted of twelve female rats, Group II of twelve males, and Group III of nine females. All animals were litter-mates born on January 23, 1947.

Throughout the course of the experiment the three groups were maintained in three group cafeterias on the following basic self-selection diet modified from Young (3).

Casein
Cod liver oil
Corn oil
NaCl, 3% solution
Potassium phosphate, 1% solution
Magnesium acetate, 0.5% solution
Sodium phosphate, 4% solution
Calcium lactate, 2% solution
Sucrose, 38% solution
Thiamin HCl, .06% solution
Riboflavin, .02% solution
B_6 (Pyrodoxine), .02% solution
Cal. pantothenate, .04% solution
Inositol, 0.1% solution
p-amino benzoic acid, .06% solution
Distilled water
Trace mineral solution

Casein was presented in a metal hopper while the rest of the components were presented by means of inverted glass bottles graduated and used as feeding tubes. Intake records for the three groups were taken every twenty-four hours at approximately the same time each day. Groups I and II were started on the diet February 27, 1947, and Group III on April 18, 1947.

After a preliminary habituation period of 25 days in the case of Group I and 48 days in the case of Group II, the determinations of the animals' preferences for eight concentrations of salt solutions were made as follows.

In addition to the 3% salt solution, seven other solutions were presented. The concentrations of these solutions were: 0.1%, 0.2%, 0.4%, 0.7%, 1.5%, 6.0%, and 12.0%. The solutions were presented side by side and in ascending order of concentration in a special place in the cafeterias allotted for this purpose. The 3% solution thus fell between the 1.5% and the 6.0% solutions. When sufficient data on the preferences, salt intake, and intake of other dietary components of the two groups had been obtained, the animals were adrenalectomized and returned to the cafeterias where exactly the same testing conditions were continued. When sufficient post-operative data had been collected, the seven salt solutions were removed and the animals' intake of salt from the remaining 3% solution was studied in order to have data on the intake of this solution after adrenalectomy to compare with those obtained during the preliminary period before the animals had been adrenalectomized.

Group III, meanwhile, was maintained on the basic diet (with 3% salt only), for 54 days, then adrenalectomized and continued under the same conditions for 28 days whereupon the preferences of these animals for the eight concentrations of salt were determined in the same manner as that described for Groups I and II. In this way the preferences of adrenalectomized animals for the salt solutions were obtained where there had been no opportunity for them to

become habituated to taking certain concentrations.

Results

Upon presentation of the eight concentrations of salt immediately following the preliminary habituation period, in the case of Groups I and II, a clear-cut preference in favor of the 0.7% salt solution was obtained. Appreciable amounts of the 1.5% solution were also taken. Before adrenalectomy Group I on the average took from 15-30 cc. per day of the 0.7% solution, and from 0-5 cc. per day of the 1.5% solution. Group II under the same conditions took from 25-40 cc. per day of the 0.7% solution and from 0-6 cc. of the 1.5% solution. For both groups the intake of the remaining five salt solutions was at or near zero. The period of observation for Group I was 19 days and for Group II 43 days.

Following adrenalectomy, the same relationships were obtained for both groups. That is, adrenalectomy failed to result in a change in the preferences, and both groups continued to discriminate in favor of the 0.7% and 1.5% solutions. The same result was obtained for Group III when the preferences of this group were studied following adrenalectomy. These observations were made for a 23-day period for Group I, for 58 days for Group II and 17 days for Group III. The failure of adrenalectomy to result in a change in the preferential relations is explained in terms of the results found for solid salt intake during these observational periods. A discussion of this follows.

For Groups I and II the average daily intake of salt from the 3% salt solution for the preliminary periods was .051 gr. and .110 gr. respectively. For the pre-operative period on eight concentrations of salt the combined total intake of salt averaged .179 gr. per day for Group I and .239 gr. per day for Group II. Thus, because of the high palatability of the 0.7% and 1.5% solutions, the animals were ingesting two to three times the amount of salt that they had been taking while on the 3% solution during the

preliminary periods of observation. At the same time both groups had access to a 4.0% solution of sodium phosphate, and were deriving sodium from this solution. In the post-operative periods for the two groups the salt intake did not rise significantly. However, when an analysis was made of the amount of sodium being derived from both the salt and sodium phosphate solutions, it was found that the animals were already taking sufficient quantities of this substance to prevent the appearance of the deficiency symptoms commonly reported in adrenalectomized animals. It was concluded, therefore, for Groups I and II, that the animals did not voluntarily increase their salt intake following adrenalectomy since they were already ingesting unusually large amounts of sodium by way of the salt and sodium phosphate solutions.

For Group III, which remained on 3.0% salt for 29 days following adrenalectomy, no significant increase in salt intake was observed. Since the mean intake of salt during this period was only .070 gr. per day, this was hardly sufficient to prevent the symptoms of adrenal-cortical insufficiency. However, an analysis of the sodium phosphate intake for this group revealed that the intake was higher than that recorded for Groups I and II under post-operative conditions on eight salt solutions. When the total amount of sodium was computed for Group III it was found to be comparable in amount to that taken by Groups I and II.

Graphic plots of the intake data for sodium chloride and sodium phosphate further revealed that there was a reciprocal relationship in the intake of the two substances. That is, during those periods when relatively little salt was being ingested, as was found to be the case when salt was presented in the 3% solution only, a relatively large amount of the sodium phosphate was ingested. When, however, large amounts of salt were being ingested, as was found to be true of those periods when salt was presented in eight concentrations, relatively small amounts of the sodium

phosphate solution were taken.

These two factors taken together may be the explanation of why the preferential relationships remained constant before and after adrenalectomy. That is, the purpose of adrenalectomizing the animals was to create a sudden and severe sodium insufficiency, but the rats by the voluntary ingestion of sodium from one or the other of two sources effectively prevented such a state of insufficiency. It is realized, however, that such an interpretation does not preclude the possibility that the animals' relative preferences might have remained the same even though a need for sodium had been successfully brought about.

In regard to the dietary components other than salt and sodium phosphate, it was observed that the introduction of the eight concentrations of salt caused some falling off in intake in all of them but especially of the vitamins. The animals, however, had been taking such large quantities of all of the vitamins with the exception of thiamin that they were far in excess of their daily minimal requirements, as cited by McCoy (4), and the decreased intake had no detrimental effect. Adrenalectomy had no observable effect on the intake of the dietary components other than that already discussed for salt and sodium phosphate.

Conclusions

Within the limits of the experiment the following conclusions were drawn:

1. For normal rats the preferred among the 8 salt solutions presented was found to be 0.7%. The 1.5% solution was the animals' second choice.

2. The above preferences were also found to hold for adrenalectomized rats where unlimited amounts of sodium are available and a large amount is actually ingested.

3. An inverse relationship was demonstrated between

the appetites for sodium chloride and sodium phosphate.

4. A two- to three-fold increase in solid salt intake was shown to result from the introduction of highly palatable salt solutions into the diet.

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VITA

James Patrick Chaplin was born at Santa Monica, California, on January 6, 1919. He attended elementary school and high school at Albuquerque, New Mexico, and was graduated from high school in 1936. He entered the University of New Mexico in September, 1936, and received the Bachelor of Arts degree in June, 1940, with a major in psychology. He continued at the University of New Mexico as a graduate student and received the Master of Science degree in psychology in June, 1941. During this time he held an appointment as a teaching fellow in the department of psychology. In October, 1941, he entered the University of Illinois as a graduate student and as a half-time research assistant in psychology. He withdrew from the university in July, 1942, for military service in the Aviation Psychology Program of the Army Air Forces. He resumed study at the University of Illinois in January, 1946. He was appointed a fellow in psychology for the school year 1946-47.